

**REMARKS**

Claims 1-3, 6, 7 and 9-23 are pending in the application. Of the above claims 9 and 10 are withdrawn from consideration and claims 1-3, 6,7 and 11-23 are rejected.

**I. Claim Objections**

Claims 16, 19 and 21-23 are objected to for minor informalities. Applicants respectfully request the Examiner to withdraw these objections in view of the self-explanatory claim amendments made herein.

**II. Claim Rejections - 35 U.S.C. § 112**

Claims 15 and 18 stand rejected under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. In particular, the Examiner assets that the recitation of “the thickest portion of the first layer” is unclear as to which portion the Applicant refers to.

Claim 15, as amended, recites that “the thickness of the first layer is a thickness of a thickest portion of the first layer which has a maximum height of the first layer.” Thus, a person of ordinary skill in the art would readily understand that the thickest portion is a portion of the first layer which has a maximum height of the first layer. Accordingly, the “thickness of the first layer” recited in claim 3 is the thickness of this thickest portion, as opposed to another portion which doesn’t have a maximum height.

Additionally, claim 18 recites that “the thickness of the first layer is the thickest portion of the first layer having a maximum height.” The “thickest portion” refers back to claim 17 in which the thickest portion of the upper surface of the first layer clearly corresponds to the

maximum protrusion of the first layer. Thus, a person of ordinary skill in the art would readily understand which portion of the first layer the thickest portion refers to.

Applicants respectfully request the Examiner to withdraw these rejections in view of the above remarks.

**III. Claim Rejections - 35 U.S.C. § 103**

In view of Ota and Steigerwald

Claims 1-2, 6-7 and 11-14 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Ota et al. (6,442,184) in view of Steigerwald et al. (2004/0113163).

Applicants traverse the rejection based on the following comments.

**A. Claims 1 and 7**

Claim 1, recites:

a sapphire substrate, and a plurality of Group III nitride semiconductor layers provided on the substrate, wherein a first layer which is in contact with the substrate is composed of silicon-doped  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  ( $0 < x \leq 1$ ) and has a structure formed of aggregated columnar crystal grains having a width of 10 to 50 nm.

The Examiner asserts that the claimed first layer reads on the first crystal layer 3 of Ota. However, Ota teaches that the first crystal layer 3 consists of pyramidal crystal grains with faces non-parallel to the substrate 1 (col. 3, lines 1-4). The crystal grains are pyramidal such that the boundary between the first and second layers 3 and 4 are angled, leading to a reduction in density and good luminescence characteristics (Abstract and col. 4, lines 36-54). Thus, not only does Ota fail to teach aggregated columnar crystal grains, Ota teaches away from adopting a structure having columnar grains.

Figures 2A-2D of Steigerwald also illustrate that the islands of the textured layer 37 have angled sides to promote optical scattering (paragraph 14). These islands also resemble a “pyramidal” shape. Thus, Steigerwald also fails to teach aggregated columnar crystal grains.

The Examiner further considered that it would have been obvious to find an optimum workable range as claimed in claims 1 and 7. However, a particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges thereof might be characterized as “routine experimentation.” MPEP § 2144.05. In this case, the Examiner has pointed to nothing in Ota or Steigerwald which suggests forming of aggregated columnar crystal grains having a width of 10 to 50 nm, as recited in claims 1 and 7. Thus, it is unclear how the Examiner could reasonably conclude that the subject matter of claims 1 and 7 relates to art-recognized result-effective variables.

In addition, the Examiner states on page 3, paragraph 2, of the Office Action that Fig. 3 of Ota discloses a Group III nitride semiconductor device comprising a substrate (1 + 2). However, the substrate in Ota is the layer 1 of sapphire (see column 2, line 63, of Ota) and the layer 2 is a low-temperature buffer layer of AlN or GaN formed on the sapphire substrate 1 (see column 2, lines 65 to 67, of Ota). Therefore, Ota does not disclose that the first layer in the claimed invention “is in contact with the substrate,” as recited in claim 1. More particularly, if the substrate in Ota is taken as (1+2), the layer 2 (upper surface of the substrate) is a low-temperature buffer layer of AlN or GaN. Consequently, the first crystal layer 3 of Ota is in

contact with the AlN or GaN buffer layer 2 and is not in contact with a sapphire (i.e., Al<sub>2</sub>O<sub>3</sub>) substrate as required by present claim 1.<sup>2</sup>

Further, The Examiner states on page 3, paragraph 4, of the Office Action that it would have been obvious to one of ordinary skill in the art to provide the composition of the first layer of Steigerwald in Ota, in order to scatter light out of the device. However, in the claimed invention, the object of forming the first layer is not to scatter light out of the device, but to improve crystallinity and to increase reverse withstand voltage (see page 3, lines 23 to 29, of the present specification).

Therefore, Applicants submit that claim 1 is not obvious in view of the combination of Ota and Steigerwald for at least the above reasons, and the rejection should be withdrawn.

**B. Claim 6**

Claim 6 recites that “the first layer has a thickness of 20 nm to 200 nm.” The Examiner apparently concedes that Ota fails to teach this feature of claim 6, and cites to Steigerwald for teaching the same. In particular, the Examiner asserts that Steigerwald teaches that the textured layer 37 has a thickness (height) between 0.06 micron (60 nm) and 1 micron (1,000 nm) which includes the claimed range. However, Ota teaches that the first crystal layer 3 has a thickness of 1 micron (1,000 nm) or of 5 microns (5,000 nm) (col. 3, lines 35-36, and col. 4, lines 1-2), which is significantly larger than the claimed thickness. Thus, there is no apparent reason which would lead one of ordinary skill to significantly reduce the thickness in Ota such that the first layer 3 has the claimed thickness.

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<sup>2</sup> The sapphire substrate of the invention is described bridging pages 14-15 of the specification.

The Examiner attempts to reconcile this deficiency by asserting that it would have been an obvious matter of finding an optimum workable range. But again, the Examiner has pointed to nothing in Ota or Steigerwald which suggests reducing the thickness of the layer in Ota. Thus, it is unclear how the Examiner could reasonably conclude that the subject matter of claim 6 relates to art-recognized result-effective variables.

Applicants submit Ota fails to teach or fairly suggest the features recited in claim 6, and that claim 6 is patentable for at least this reason.

**C. Claims 2, 11 and 12**

Applicants submit that these claims are patentable at least by virtue of their respective dependencies.

**D. Claims 13 and 14**

Applicants submit that claim 13 should be patentable over the prior art for reasons similar to those presented above in conjunction with claim 1.

Also, claim 14 recites that “the first layer is a **continuous layer** formed by a **continuous formation of the columnar crystal grains**.” On the other hand, Ota discloses that the pyramidal grains are distributed at random like islands (col. 3, lines 1-4) and Figure 2 of Ota clearly shows that the grains are randomly scattered about the substrate. Thus, a lower density can be achieved (Abstract). However, the random placement of islands does not result in “a continuous layer formed by a continuous formation of the columnar crystal grains.” Thus, Ota fails to disclose this feature.

Furthermore, the Examiner asserts that “the first layer is a continuous layer **formed by a continuous formation of the columnar crystal grains**” is drawn to a process which does not

change the end product. However, this feature describes the structure of the first layer, being made of or formed by a continuous formation of the columnar crystal grains. Thus, the product itself is “a continuous layer formed by a continuous formation of the columnar crystal grains.” This feature does not describe a process or method of forming the first layer. Therefore, the Examiner should give patentable weight to all the features recited in claim 14.

Applicants submit that claim 14 is patentable for at least the above reasons.

In view of Ota

Claims 3 and 15-23 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Ota et al. Claim 3 recites, *inter alia*:

a substrate, and a plurality of Group III nitride semiconductor layers provided on the substrate, wherein a first layer which is in contact with the substrate is composed of  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  ( $0 \leq x \leq 1$ ), and the difference in height between a protrusion and a depression which are present at the interface between the first layer and a second layer provided thereon is 10 nm or more and is equal to, or less than, 99% the thickness of the first layer. (emphasis added)

The Examiner concedes that Ota fails to explicitly teach that the difference in height between a protrusion and a depression, which are present at the interface between the first layer and a second layer provided thereon, is 10 nm or more and is equal to, or less than, 99% the thickness of the first layer. However, the Examiner asserts that providing the claimed difference in height between a protrusion and a depression would have been an obvious matter of finding an optimum workable range.

The Examiner has pointed to nothing in Ota which suggests forming a first layer in which the difference in height between a protrusion and a depression which are present at the interface between the first layer and a second layer provided thereon meets the specific and unique

requirements recited in claim 3. Thus, it is unclear how the Examiner could reasonably conclude that the subject matter of claim 3 relates to art-recognized result-effective variables. The unique relationships of the difference between the protrusion and the depression to the thickness of the first layer is neither taught or fairly suggested by Ota.

In addition, as for the maximum difference in height between protrusions and depressions present at the surface of the first layer, it is described on page 7, line 30 to page 8, line 10 of the present specification that when the maximum height difference is smaller than 10 nm, single crystal growth starts at a greater number of selected crystal grains, which is not desirable from the viewpoint of control of the crystal growth, and in contrast, when the maximum height difference is excessively large, a group III nitride semiconductor single crystal having a mirror surface fails to be obtained.

Such an effect of the present invention is neither described nor suggested in Ota, and is also not obvious to one of ordinary skill in the art.

Thus, Applicants submit that claim 3 is patentable for at least the above reasons.

Applicants submit that claims 15-23 should be patentable over Ota for similar reasons set forth above.

#### V. Conclusion

Please note that since the Examiner has wide discretion in entering Amendments after a final Office Action, our response to the final Office Action may not avoid the need to take further action, such as filing an appeal, a continuation application, or a Request for Continued Examination (RCE), by the due date of **September 3, 2009**.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

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